## My Exhibition: Personalising Unencumbered Multimedia Content in a Museum Environment

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### Background

This project arose from an EPSRC research network, *Affective Communication in Design*, led by Prof. Tom Childs of University of Leeds, with co-investigators from Leeds, Sheffield, York and Sheffield Hallam Universities. In that two-year project we explored affect in exhibitions and products culminating with a conference that revealed a wide range of possibilities and positions. Some contributors focused on scientific approaches, for example affective engineering[1] and studies of the brain.[2] Social research investigated affect as an aspect of performance and experience[3] and practice-led research approaches explored affect as the outcome of creative practices in design and film-making.[4]

The *My Exhibition* research group includes specialists in engineering, human computer interaction, information studies, social anthropology, linguistics, design and media practice. It was a practice-led design project where practitioners from engineering, media arts and design collaborated to develop a practical vehicle to explore some implications of personalised ubiquitous computing. We also aimed to gain an understanding of how such an interdisciplinary research collaboration can work given the very diverse knowledge and expectations of the partners.

[1] BARNES, C. and LILLFORD, S. P., 2007. Affective design decision making – issues and opportunities. *CoDesign – Affective Communications in Design, Challenges for Researchers,* 3(Supplement 1), pp. 135–146.

[2] DE PENNINGTON, N., et al., 2007. Neuroimaging of sensory and affective experience in the human brain. *CoDesign – Affective Communications in Design, Challenges for Researchers,* 3(Supplement 1), pp. 45–55.

[3] HEALEY, P. G. T. and LIGHT, A., 2007. When scoring doesn't matter: the aesthetics of performance in arcade games. *CoDesign- Affective Communications in Design, Challenges for Researchers,* 3(Supplement 1), pp. 91–96.

[4] *Nanotechnology and the Running Shoe: Shock Revelation!*, 2005. Documentary video. Directed by Richard JONES. Sheffield: University of Sheffield and Sheffield Hallam University. Available at: <http://www.nanoscience.dept.shef.ac.uk/images/gallery05/video1.php>.

## Context

We set out to explore how people's experience of interactive media in public spaces might be 'personalised'. Behind this relatively simple statement lies a variety of assumptions, conditions and sub-texts.

The location was a public museum, the Royal Armouries in Leeds. However we assumed that the work would be valid in anywhere that rich and complex material might be available to a variety of people with differing interests and inclinations. Our imagined audience would not be engaged in information-seeking, the 'goal-driven rational behaviour' assumed in many studies of interaction.[5] Instead we assumed that the audience might expect to be informed or entertained but have no explicit goals. Falk and Dirking[6] explain that some museum visitors are goal driven but others are not. We found that some of our visitors had expert interests in history or calligraphy, but others showed no evidence of any specific interest.

During the project we adopted the idea of 'values' as a thinking tool although we did not engage with values as an issue in itself. Rather we used it as shorthand for ways of organising material and interests to reflect the different agendas that individuals and groups bring to a museum visit or other experience.

The project has been concerned with the implications of future technologies. We were interested in working with large sets of images, sounds, speech and texts, and technologies now emerging will make it possible for such material to be presented in a variety of ways that are 'unencumbered' by today's computing hardware. In theory at least, any surface might display dynamic images, sounds might be directed exclusively to any individual or group in a public space and the precise location, posture and identity of any individual within that space might be known at any moment. We replicated some of these functions, using existing techniques which provided usable, if limited, unencumbered interaction.

Some research, for example Ehn and Kyng's low-fidelity mockups[7] and 'Wizard of Oz' (WOz) methods where a human operator 'drives' the interface rather than a computer, has been successful without replicating future software and hardware. However, we were concerned with the visceral or affective qualities of interaction where timing and responsiveness are critical; a human operator cannot simulate the responsiveness of a computer system as seen in Dahlbäck *et al's*

[5] TORREY, C., CHURCHILL, E. F. and MCDONALD, D. W., 2009. Learning How: the Search for Craft Knowledge on the Internet. *In: Proceedings of the 27th international Conference on Human Factors in Computing Systems, CHI-09, Boston, 4–9 April 2009*. New York: ACM Press, pp. 1371–1380.

[6] FALK, J. and DIERKING, L., 1992. *The Museum Experience*. Washington: Whalesback Books.

[7] EHN, P. and KYNG, M., 1991. Cardboard Computers: Mocking-it-up or Hands-on the Future. *In:* J. GREENBAUM and M. KYNG (eds.), *Design at Work: Cooperative Design of Computer Systems*. Mahwah, NJ: Lawrence Erlbaum Associates, pp. 169–195.

[8] DAHLBÄCK, N., JÖNSSON , A. and AHRENBERG , L., 1993. Wizard of Oz Studies: Why and How. *In:* W. D. GRAY, W. D. HEFLEY and D. MURRAY (eds.), *Proceedings of the 1st International Conference on Intelligent User Interfaces, Orlando, 4–7 January 1993*. New York: ACM Press, pp. 193–200.

discussion of WOz[8] and Dow *et al*'s[9] description of WOz in an interactive 'visitor experience' application with location sensing and audio content. Thus it seemed important to create some interaction with real software as well as more detached scenarios.

The research was driven also by an interest in personalisation or 'mass customisation', important in manufacturing and in web design. For many years technology and industrial management has focused on individualised products or experiences,[10,11] or designs that allow visitors to find personalised material on websites.[12] While it is widely understood that consumers have diverse tastes and interests and marketeers have sophisticated ways to describe that,[13] we do not have equally sophisticated ways for consumers to shape experiences through direct action.

One of our challenges was to provide tacit interaction but build on the experience of engineers designing systems to support explicit customer choices. Other research investigates how consumers might shape products for themselves,[14] but we aimed to operate at a visceral, tacit level, allowing individuals to reveal interest without making explicit choices. This is only a partial aim; such systems can become oppressive and unethical, so participants must be aware of them and have the freedom to influence and subvert them, which implies some explicit choice and manipulation by users. Critics warn against oppressive use of 'spy' technologies[15] but they might be enabling if people can control when and how they operate.

We needed a design approach that used the different kinds of expertise and experience in the interdisciplinary group. Apart from creating a workshop environment to evolve our thinking and having people who were genuinely interested in each other's ideas, we exploited and developed scenario-based methods previously developed by members[16] using literary pastiches to introduce 'ready-made' characters and situations to design scenarios. We were also interested in the practical use of Web 2.0 techniques and this proved timely as some web-based tools for collaboration had reached a good level of development. In this inter-university project we used publicly available web resources to ensure sharing of planning, materials and knowledge.

Finally we needed an arena which was provided in a timely and engaging way by the Royal Armouries Museum and their exhibition, with Prof. Peter Ainsworth of University of Sheffield, based on the mediaeval *Chronicles of Froissart*. Jean Froissart was a court poet and historian, connected with both sides of the 100 Years War, who gathered a rich and contemporaneous account of the history of the war and ordinary

[9] DOW, S., et al., 2005. Wizard of Oz support throughout an iterative design process. *Pervasive Computing,* 4(4), pp. 18–26.

[10] MATHER, H., 1988. *Competitive Manufacturing.* New York: Prentice Hall.

[11] GILMORE, J. H. and PINE, J., 1997. The four faces of mass customisation. *Harvard Business Review,* Jan–Feb.

[12] KOBSA, A., KOENEMANN, J. and POHL, W., 2001. Personalised hypermedia presentation techniques for improving online customer relationships. *The Knowledge Engineering Review,* 16(2), pp. 111–155.

[13] GOSS, J., 1995. We know who you are and we know where you live: the instrumental rationality of geodemographic systems. *Economic Geography,* 71(2), pp. 171–198.

[14] ATKINSON, P., et al., 2008. Post Industrial Manufacturing Systems: The Undisciplined Nature of Generative Design. *In:* D. DURLING, et al. (eds.), *Proceedings of the Design Research Society Conference 2008, Sheffield, 16–19 July 2008*. Sheffield: Sheffield Hallam University.

[15] ALBRECHT, K., et al., 2003. *Position Paper on the Use of RFID in Consumer Products* [online]. Available at: <http://www.spychips.com/jointrfid_position_paper.html>.

[16] BLYTHE, M. and WRIGHT, P., 2006. Pastiche scenarios: fiction as a resource for user centred design. *Interacting with Computers,* 18(5), pp. 1139–1164.

people's experiences in it. His masterpiece of journalism became the text for illustrated manuscripts produced for rich clients by a Parisian entrepreneur, Pierre de Liffol. While Froissart's text was unvaried, each book was produced with an eye to the prejudices of the purchaser, influencing the visual narrative in the stylised illustrations. Like contemporary movies, the books were a product of a network of studios and master craftsmen, with similarly high budgets.

Figure 1, Image from The Chronicles of Froissart, Bibliothèque Municipale Besançon, ms 864, fol 150. Reproduced by permission of Bibliothèque Municipale Besançon

Peter Ainsworth and calligrapher/photographer, Colin Dunn, had photographed the chronicles in museums and libraries around the world. These, plus a Froissart manuscript loaned by Stoneyhurst College and the Royal Armouries' mediaeval arms and armour collection, provided the raw material for the exhibition, which included physical, graphical, audio-visual and interactive elements. Our project team created an introduction to the exhibition in a wide entrance corridor.

## Methods / Approach / Journey

We had two main programmes of work; design and social research; but these overlapped and the design process became a more important aspect of the research than the study of visitors to the exhibition.

The core design group included systems engineers at Leeds University and an art/design/media group at Sheffield Hallam. Other project members were involved through a workshop series, running weekly during the most intensive design development. We started with a speculative, concept-building session, in a corridor that already contained 2D and 3D display materials to imagine how materials and techniques might be employed to create 'natural' interactions. For example we explored metaphors such as a torch to explore graphical material, triggering 'hot spots' to respond in various ways and we discussed/enacted how groups of individuals, each known to the system and with different agendas, might interact with each other to make sense of the interactions.

A graphical storyboard then set out the main ideas, shared on the project wiki. We used characters from *The Simpsons*, easily recognised individuals with well-known agendas, as a tool for exploring design scenarios, in a tentative way in these storyboards which became our reference source of practical/technical design ideas. Later *The Simpsons* became full-blown members of the project team as described below.

The design effort took on two themes: technology and content/interaction thinking. Technology assessment sought available technology for unencumbered interaction, embedding audio-visual materials 'naturally' in the environment controlled by personalised data. We were restricted by unexpected factors in the environment and technical limitations in the state of the art. On the other hand some rather vaguely-stated hopes for subtle interaction through posture and positioning became real elements. Moore's Law[17] changed the project's technical plans several times with falling costs and improved performance in some technologies.

Content and interaction development was also fluid and unpredictable, partly because it involved several disciplines. Tensions between the project's very ambitious, evolving aims and the priorities/limitations emerging in individual pieces of creative work were inevitable. We planned to exploit materials in the main exhibition, using lighting, audio and other dynamic content to enhance the exhibits in personalisable ways. However the curators acquired other, explicit, interactive content which prevented us applying an interactive layer in the way we had expected.

The alternative plan was to use a 2m wide entrance corridor for an exhibit that introduced key ideas about the exhibition. This gave more technical freedom to support the research, but it gave us the problem of creating new content from scratch.

[17] Moore's law describes a long-term trend in the history of computing hardware, in which the number of transistors that can be placed on an integrated circuit has increased exponentially since 1962. Almost every measure of the capabilities of digital electronic devices is strongly linked to Moore's law, for example, processing speed and memory capacity.[18]

[18] WIKIPEDIA. 2009. Available at <http://en.wikipedia.org/wiki/Moore%27s_law>.

An early stimulus for our personalisation strategy was recognising the distinct personalities and passions of people, historical and contemporary, who influenced the exhibition. The journalist's instincts of Jean Froissart, the glamour and pride of Sir John Chandos, a key figure in the war, the forensic insights of Karen Watts, Curator of Armour and the scholarly passion of Prof. Peter Ainsworth all illuminated the exhibition and seemed to represent different values that visitors might associate with. We identified a set of 7 working 'values', particular to this exhibition, to inform development of content and personalisation.

These values did not define 7 separate types of visitor but might form the basis for a wide variety of profiles to help create individualised experiences. Cultural researchers, such as Hofstede and Bond[19] and Smith *et al*[20] seek to identify relatively fixed frameworks of significant values that might predict the behaviour of people in communities. In contrast we used the term 'value' as a working concept, not related to any particular theory of values or culture, but simply shorthand for the particular focus or interest that an individual or group brought to the material in the exhibition.

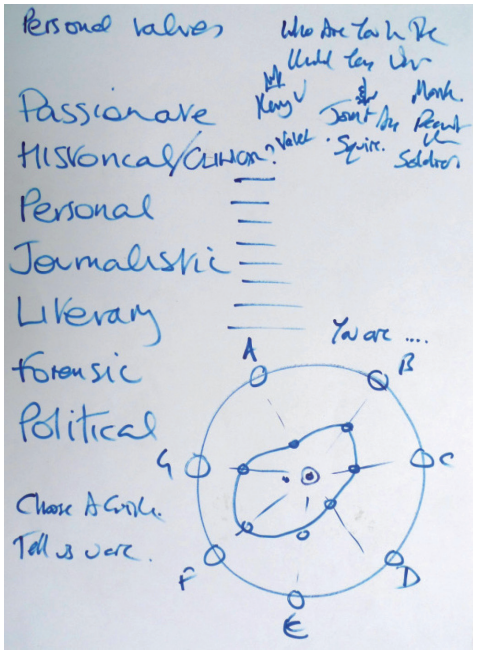


Figure 2, Initial table of 'values' developed in early review of content including an initial sketch of the value profile concept developed in the software

[19] HOFSTEDE, G. and BOND, M. H., 1984. Hofstede's culture dimensions, an independent validation using Rokeach's value survey. *Journal of Cross-Cultural Psychology,* 15(4), pp. 417–433.

[20] SMITH, P. B., PETERSON, M. F. and CHWARTZ, S. H., 2002. Cultural values, sources of guidance, and their relevance to managerial behavior: a 47-nation study. *Journal of Cross-Cultural Psychology,* 33(2), pp. 188–208.

This led into development of content, initially through video production led by Jeff Baggott,( Sheffield Hallam University) with the Royal Armouries' actor/interpreters. As this material emerged with other members of the project group assisting or reviewing it, we realised that producing high quality video was too time consuming to provide sufficient content for our needs with our resources. An audio content programme was therefore started, led by Mark Blythe, primarily a social researcher, trained and equipped by Jeff Baggott to create audio material. A variety of professional and amateur actors, acted scenes from the chronicles and experts provided commentaries that responded to our initial scheme of values. Subsequently this audio material formed the main interactive content, with the professional video illustrating what might be achieved in practice, allowing exploration of some technical possibilities.

The material was coded, as ethnographic material might be coded using content analysis. Broad categorisations were agreed and an initial coding was then checked and modified with another coder (inter-coder agreement was high). This led to 7 new categories or 'values' (horror, comedy, passion, politics, daily life, personal experience and history).
This review and restatement of our 'values' indicates a method that worked through iterations of a value scheme, refreshing it by examining the actual material as it emerged. This approach to what is essentially a 'wicked problem' of evolving content, interaction scheme and technical underpinning in parallel has similarities to other current research[21] where cycles of creative work and group reflection allow space for tacit interpretation by designers carrying out subsequent cycles of making (in this case the term 'designer' refers to all who make a creative contribution). This can be described[21] using Polanyi's reasoning on tacit knowledge,[22] with designers employing their tacit experience of the reflective discussion (Polanyi's 'proximal' element) in producing new explicit material (the 'distal' element). The approach also illustrates Rittel and Webber's[23] process of resolving wicked problems:

'*an argumentative process in the course of which an image of the problem and of the solution emerges gradually among the participants, as a product of incessant judgement, subjected to critical argument.*'

[21] BOWEN, S., 2009. *A Critical Artefact Methodology: Using Provocative Conceptual Designs to Foster Human-centred Innovation*. PhD Thesis, Sheffield Hallam University.

[22] POLANYI, M., 1966. *Tacit Dimension*. 1983 ed. Gloucester, MA: Peter Smith.

[23] RITTEL, H. W. J. and WEBBER, M. M., 1984. Planning Problems are Wicked Problems. *In:* N. CROSS (ed.), *Developments in Design Methodology*. London: J Wiley and Sons, pp. 135–144.

Meanwhile the parallel exploration of technology had tested various techniques to capture position, identity and action of participants and to embed audiovisual material into the environment, simulating future technology. Selective use of lighting was considered, using spotlights and backlighting to emphasise hotspots. 'Bare' liquid crystal display(LCD) screens were tested in configurations that might reveal visual content on demand but conceal the presence of the technology, similarly to theatrical ghost effects using differential lighting before and behind a gauze curtain.

We also explored printing techniques and substrates to provide 'front' and 'rear' content on a printed display. Most techniques tested could be persuaded to work in isolation in perfect conditions, but not reliably enough to work in a semi-controlled environment. We also tested directional audio and found it very promising for targeting sound on hot spots in open spaces in the main halls of the museum, our confined corridor created too much reflection.

Similar effects were found when attempting to locate badges that broadcast 'active radio-frequency identification (RFID)' signals. They were detected but in our confined space the intensity of the radio signals was not predictable enough for triangulation. RFID is widely used in interaction schemes but only where the user actively signals their presence, for example by 'swiping' a passive RFID card against a sensor.

Eventually we compiled a technical plan that worked sufficiently for a public test of the personalisation scheme.

In our entrance corridor, approximately 15m x 2m, we installed a false wall along one side. It appeared to be a conventional display of printed graphics showing images from the Froissart chronicles with some text about the exhibition.

The wall concealed digital cameras, light boxes behind selective areas of images and text printed on the rear of translucent sections, loudspeakers and amplifiers and computers to control these devices and distribute audio content. The key to the interactions was a system of badges worn by visitors, each with a different colour to identify them. A computer analysed live camera images of the corridor to identify who was standing where in relation to the display which, had ten 500mm wide 'stations' along its length.

This system was sensitive enough that a person could trigger the different stations to perform by swaying from side to side across the boundary between them, or could trigger the system to start or stop by turning towards or away from the wall, providing bodily interaction that might be become 'intuitive' in a short time. Initial evaluation with Royal Armouries staff indicated that this was a very engaging form of interaction and the exhibition curator was quick to become interested in its potential.

Interaction needed a way of managing and personalising content, developed by the systems engineers. The concept of values led to the idea of value profiles, an array of linear scales indicating the visitor's interest in the different values we were using. At the start of the visit these could be derived from interviews or some explicit interactive method later modified by the system 'on the fly', as the visitor's actions revealed more or less interest.

The software reflected our dual focus. The 'front end' used Max[24]/MSP (manage service provider) software to managed the sensors and audiovisual content, informing the MySQL[25] 'backroom' database system about the location and identity of visitors. This in turn instructed the front end what content to present while updating visitor profiles. The software mix reflected the interdisciplinary mix.

Max/MSP is visual software widely used by artists to control hardware and content, used by an artist/programmer (James Brown). MySQL provides a more traditional database programming environment used by a software engineer (Pete Dawson), the two collaborating to build a complete system using MySQL to maintain a complex data structure and Max/MSP to control a diverse set of dynamic elements.

Finally we needed to create the visitor's initial profile before they entered the exhibition, achieved by offering a way of moving forward and back through short animations with a physical dial to find a location in each animation that felt 'comfortable' to them, matching a point on one of the value scales. This was done in an explicit and humorous way, for example, an execution scene which became progressively more gory, introducing the visitor to the principles at work. However, having developed this tool, we will have the opportunity in future to explore more subtle ways to use visual material to represent a range of ideas or scale of interest, since any sequence of images might be combined to provide a progressive scale of options.

[24] An interactive programming environment for music, audio and media.

[25] My Structured Query Language. A relational database management system, which runs as a server providing multi-user access to a number of databases.

During the development of content and technical systems we needed ways to share concepts and explore their implications. Previously Blythe and Wright[16] had developed the use of literary pastiches in the style of well-known authors to create recognisable scenarios. *The Simpsons* characters which were introduced explain some early technical scenarios, borrowed from a previous presentation which used them to anonymise participants in confidential industrial research.[26]

[26] RUST, C., 2004. Creative Methods for Unlocking Consumers' Tacit Knowledge: Practical Tools for Designing User Experiences [invited paper]. *Presented at Faraday Packaging Partnership Farapack Briefing, York, 21–22 October 2004.*

We recognised that the Simpsons provided a rich cast of well-developed characters and experiences and one of Mark Blythe's roles in the project was to create short stories that showed how the different characters might react when confronted with aspects of the proposed exhibition.

**Voice:** Meeting the Dauphin at Chinon castle, she conquered his skepticism as to her divine mission. In September 1429, Joan unsuccessfully besieged Paris. The following spring she went to relieve Compiègne, but she was captured by the Burgundians and sold to the English, who were eager to destroy her influence by putting her to death.

**Lisa:** Oh Mom! I'm learning!

*Marge comes over looking concerned and alarmed*

**Marge:** What about?

**Lisa:** Joan of Arc

**Voice:** She was condemned to life imprisonment. Shortly afterward, however, she was burned at the st –

*Marge drags Lisa away*

**Lisa:** Mom I was listening to that!

**Marge:** What? It was the end. She was pardoned. They lived happily ever after. Come on Lisa, I forgot to open a window in the car; your Father will be starting to overheat.

Figure 3, Example of Pastiche Scenario

The resulting exhibition allowed us to explore how people deal with such interactions and reflect on our experience of designing for it. Having developed a working tool it was necessary to make it available for future research. Following the exhibition and some further work on how to incorporate 'invisible' LCDs, we redesigned the interactive exhibit as a portable system of 5 'black boxes' that allow a wide variety of digital content. We are now working with curators and designers to evaluate how they might use such a system and design for it, using an oral history archive from English Heritage as prospective content.

All this ambitious and complex development effort meant that the fieldwork had to be compressed into a relatively short period, more so because there were several changes in the Royal Armouries timetable completely outside our control. Real world events create very inflexible laboratories.

## New Knowledge and Understanding

We have learned a lot about how to design for unencumbered, tacit interaction and about working with complex interdisciplinary problems. We have learned a little about how people respond to this kind of interaction. This was a very ambitious project and we have learned some practical lessons about conducting such research. Finally we have developed ideas about further work to clarify and develop these techniques and built tools to help with that further work.

These new media require new kinds of designers. The design challenge integrated a variety of digital hardware and software with more conventional, audio, lighting and 3-dimensional thinking. When recruiting researchers it was evident that many design graduates have rather limited concepts of their roles, not recognising the challenges we faced, but some artists had developed relevant eclectic sets of practical knowledge and skills combined with an understanding of the experiential aspects of the work. Our more traditional software engineer provided a vital sense of structure to the project to balance the individualism of the artists. The core design/prototyping team of researchers, investigators and technicians finally included a software engineer; an artist/programmer with experience of installing electro-mechanical devices in artworks; another artist with extensive experience as a scene builder in the film industry; two furniture design graduates with experience of computer numerically controlled (CNC) production, vital for building custom electronic displays; film/video-makers and a human-computer interaction (HCI) researcher with an active interest in audio recording and editing.

This interdisciplinary mix creates problems with both practice and expectations. We needed a balance between our various professional expectations, and what is realistic in practice, to carry out the research. Some of our audio content lacked the polish of the professionally produced video, but ensured a sufficient range of material for the research to investigate personalisation. The participants' coloured badges had a lashup quality as they were in development right up to the last minute. We had tension between some who saw the data from the project as its primary outcome, and others who felt it necessary to embody the work in

a lasting 'product' to support further research and demonstrations. On the other hand, our experience of past interdisciplinary debate indicates risk of mutual misunderstandings of terminology; however, personal relationships developed during the project and preceding network, which seemed to allow people to see intended meanings rather than misreading through a disciplinary filter.

The blurring of roles and exchange of skills and ideas in the practical work seemed a very positive aspect of the project. We have observed similar effects in industry, where sharing new digital working media between different disciplines has fostered convergence of roles and understanding.

The central concept of 'values' provided an essential focus for the development work, allowing an iterative process that moved between refining strategy and developing content. Users recognised the idea of 'unspoken' values at work. Where the value concepts were more explicit, in the initial profiling exercise, it was clear that some ideas were easily recognised, but others were difficult for the users to interpret, indicating a need for more work on how to balance explicit and tacit judgements and evaluate the profiling tools in development. Since our concept of values is rather more open and fluid than previous research in cultural studies, this points to a promising area of 'experiential' knowledge which could be explored with our software and design approach.

Finally, our fieldwork, although more limited than hoped due to technical challenges and external disruptions to the planned programme, showed that the audience found the personalisation approach and unencumbered interaction system very engaging. It promoted interaction between visitors; they found the interaction method easy to understand and adopt, and they enjoyed the way it worked and recognised its value. Those who had some historical expertise felt the approach was intrinsically more engaging and relevant than other approaches they had experienced. In some tests the technology failed to perform. When that happened participants were nevertheless intrigued by the system, understood it and engaged in thoughtful discussion about how it could work for them. One of the encouraging aspects of all this is that our approach appears to have achieved the aim of an ethical system, which operates subtly in the background but ensures that users are able to recognise its presence while interacting with it intuitively.